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Title: JP10327587A2: CIRCUIT AND METHOD FOR CONTROLLING PIEZOELECTRIC TRANSFORMER

Derwent Title: Piezoelectric transformer control circuit for cold cathode lamp - uses load current feedback circuit to adjust pulses of output driving voltage in accordance with changes in load current to maintain predetermined brightness level [Derwent Record]

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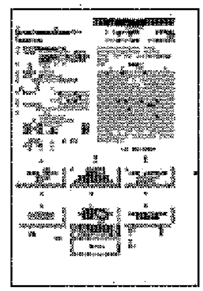

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Abstract:

PROBLEM TO BE SOLVED: To provide a circuit and a method for controlling a piezoelectric transformer which can have a function to keep the current nearly constant in a cooling cathode-ray tube, which is a load, and a function for adjusting the luminance in a wide range by an intermittent oscillation at the same time and which can put out lights and light up again by adjusting the luminance.

SOLUTION: With the oscillation duration being set to 0% in a pulse power circuit 8, a piezoelectric transformer 1 is not driven, and therefore a load current is nearly zero. At that time, the load current-detecting voltage Vri is smaller than a reference voltage Vref1 in an error amplifier circuit 5, and therefore a controlling voltage Vctr output from an error amplifier circuit 5 becomes small and an oscillation frequency shifts to a low-frequency side, beyond the resonance frequency. When the controlling voltage Vctr becomes smaller than a reference voltage Vref2, a voltage comparator circuit 9 outputs a 'Low' signal, and then a voltage-controlling oscillator circuit 6A outputs an oscillation signal for setting an upper limit frequency.

INPADOC Legal Status: None   Buy Now: Family Legal Status Report

Designated Country: BE CH DK ES FI FR GB GR IE IT LI LU MC NL PT SE KR

Family:

Buy PDF	Publication	Pub. Date	Filed	Title
	WO9835434A1	1998-08-13	1998-02-02	CONTROL CIRCUIT AND METHOD FOR

			PIEZOELECTRIC TRANSFORMER
WO9809369A1	1998-03-05	1997-08-26	CONTROL CIRCUIT AND METHOD FOR PIEZOELECTRIC TRANSFORMER
US6239558B1	2001-05-29		
US6239558	2001-05-29	1999-02-26	System for driving a cold-cathode fluorescent lamp connected to a piezoelectric transformer
US6198198B1	2001-03-06		
US6198198	2001-03-06	1999-08-05	Control circuit and method for piezoelectric transformer
TW0463396B	2001-11-11	1998-02-04	Control circuit and method for piezoelectric transformer
KR0035896A	2000-06-26	1999-02-26	CONTROL CIRCUIT AND METHOD FOR PIEZOELECTRIC TRANSFORMER
JP10327587A2	1998-12-08	1997-05-26	CIRCUIT AND METHOD FOR CONTROLLING PIEZOELECTRIC TRANSFORMER
JP10285942A2	1998-10-23	1997-09-25	CIRCUIT AND METHOD FOR CONTROLLING PIEZOELECTRIC TRANSFORMER
JP10223390A2	1998-08-21	1997-02-06	CONTROL CIRCUIT OF PIEZOELECTRIC TRANSFORMER
JP10223389A2	1998-08-21	1997-02-06	CONTROL CIRCUIT OF PIEZOELECTRIC TRANSFORMER
JP10223388A2	1998-08-21	1997-02-06	CONTROL CIRCUIT OF PIEZOELECTRIC TRANSFORMER
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EP1016206B1	2002-09-25	1998-02-02	CONTROL CIRCUIT AND METHOD FOR PIEZOELECTRIC TRANSFORMER
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DE69808322T2	2003-05-15	1998-02-02	STEUERSCHALTUNG UND -VERFAHREN FÜR EINEN PIEZOELEKTRISCHEN TRANSFORMATOR
DE69808322C0	2002-10-31	1998-02-02	STEUERSCHALTUNG UND -VERFAHREN FÜR EINEN PIEZOELEKTRISCHEN TRANSFORMATOR
DE69704082T2	2001-09-13	1997-08-26	STEUERSCHALTUNG UND -VERFAHREN FÜR PIEZOELEKTRISCHEN TRANSFORMATOR
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CN1246986T	2000-03-08	1998-02-02	Control circuit and method for piezoelectric transformer
CN1235708A	1999-11-17	1997-08-26	Control circuit and method for piezoelectric transformer
CN1175554C	2004-11-10	1997-08-26	Control circuit and method for piezoelectric transformer
AT0225096E	2002-10-15	1998-02-02	STEUERSCHALTUNG UND -VERFAHREN FÜR EINEN PIEZOELEKTRISCHEN TRANSFORMATOR
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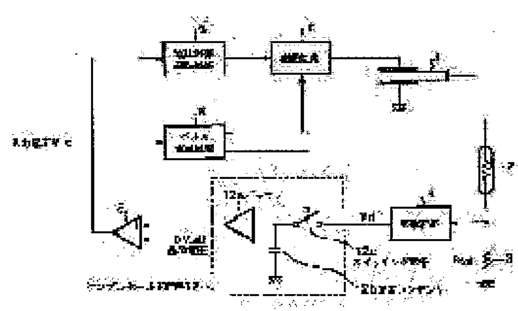
(54) CIRCUIT AND METHOD FOR CONTROLLING PIEZOELECTRIC TRANSFORMER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a circuit and a method for controlling a piezoelectric transformer which can have a function to keep the current nearly constant in a cooling cathode-ray tube, which is a load, and a function for adjusting the luminance in a wide range by an intermittent oscillation at the same time and which can put out lights and light up again by adjusting the luminance.



SOLUTION: With the oscillation duration being set to 0% in a pulse power circuit 8, a piezoelectric transformer 1 is not driven, and therefore a load current is nearly zero. At that time, the load current-detecting voltage Vri is smaller than a reference voltage Vref1 in an error amplifier circuit 5, and therefore a controlling voltage Vctr output from an error amplifier circuit 5 becomes small and an oscillation frequency shifts to a low-frequency side, beyond the resonance frequency. When the controlling voltage Vctr becomes smaller than a reference voltage Vref2, a voltage comparator circuit

9 outputs a 'Low' signal, and then a voltage-controlling oscillator circuit 6A outputs an oscillation signal for setting an upper limit frequency.

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CLAIMS

[Claim(s)]
[Claim 1] An oscillation means to generate an oscillation signal according to control voltage, and the driving means which drives a piezoelectric transformer with the alternating voltage generated according to the oscillation signal from the oscillation means, The control means which controls the oscillation frequency of this oscillation means that the load current of the load connected to the output side of said piezoelectric transformer should be detected, and the load current should be made to abbreviation regularity, It is the control circuit of the piezoelectric transformer characterized by having the sweep means which is the control circuit of preparation **************, and carries out the sweep of the oscillation frequency to predetermined frequency when the oscillation frequency of said oscillation means shifts from a predetermined control range.
[Claim 2] Said predetermined frequency is the control circuit of the piezoelectric transformer according to claim 1 characterized by the output voltage in the resonance characteristic which said control means is using among the resonance characteristics which said piezoelectric transformer has being the frequency which shows the minimal value.
[Claim 3] Said predetermined control range is the control circuit of the piezoelectric transformer according to claim 2 characterized by being contained in the frequency characteristics by the side of high frequency rather than the frequency in which the output voltage of said piezoelectric transformer takes the maximal value among the resonance characteristics which said control means is using, and including said predetermined frequency.
[Claim 4] Furthermore, it is the control circuit of a piezoelectric transformer given in any of claim 1 which generates the pulse signal for driving said piezoelectric transformer intermittently, is equipped with an intermittent oscillation means to supply the pulse signal to said driving means, and is characterized by the intermittent oscillation means containing the adjustment device which adjusts said load current by adjusting the duty ratio of the pulse signal to generate thru/or claim 3 they are.
[Claim 5] Said intermittent oscillation means is the control circuit of the piezoelectric transformer according to claim 4 characterized by being a pulse-voltage means to generate a pulse voltage from the direct current voltage used as the radical of said alternating voltage.
[Claim 6] Said driving means includes the bridge circuit which constituted the transistor in the bridge type. Said intermittent oscillation means An AND calculation means to compute an AND based on a pulse oscillation means to generate a pulse signal, and the pulse signal from the pulse oscillation means and the oscillation signal from said oscillation means, The control circuit of the piezoelectric transformer according to claim 4 characterized by driving each of a preparation and said transistor with the oscillation signal from said oscillation means, or the output signal from said AND calculation means.

[Claim 7] Furthermore, it is the control circuit of a piezoelectric transformer given in any of claim 1 characterized by said sweep means detecting that the oscillation frequency of said oscillation means shifted from said predetermined control range based on the output of this control voltage detection means thru/or claim 7 have a control voltage detection means to detect the control voltage of said

oscillation means, and they are.

[Claim 8] Furthermore, the control circuit of the piezoelectric transformer according to claim 7 which samples the output of said load current detection means synchronizing with said pulse voltage, and is characterized by having a sample hold means to hold, and a control voltage generation means to generate the control voltage of said oscillation means based on the output from the sample hold means.

[Claim 9] It is the control approach of the piezoelectric transformer which is the control approach of the piezoelectric transformer which controls this oscillation frequency that an oscillation signal should be generated according to control voltage, a piezoelectric transformer should drive with the alternating voltage generated according to the oscillation signal, the load current of the load connected to the output side of the piezoelectric transformer should detect, and the load current should make abbreviation regularity, and is characterized by to carry out the sweep of the oscillation frequency to predetermined frequency when said oscillation frequency shifts from a predetermined control range.

[Claim 10] Said predetermined frequency is the control approach of the piezoelectric transformer according to claim 9 characterized by the output voltage in the resonance characteristic which said piezoelectric transformer is using for said control approach among the resonance characteristics which it has considering as the frequency which shows the minimal value.

[Claim 11] Said predetermined control range is the control approach of the piezoelectric transformer according to claim 10 characterized by being contained in the frequency characteristics by the side of high frequency rather than the frequency in which the output voltage of said piezoelectric transformer takes the maximal value among the resonance characteristics currently used for said control approach, and including said predetermined frequency.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Concerning the control circuit and its control approach of a piezoelectric transformer, this invention is used for the driving gear of a cold cathode tube, and relates to the control circuit and its control approach of a suitable piezoelectric transformer.
[0002]
[Description of the Prior Art] In recent years, the liquid crystal display is widely used for the easy note type personal computer of carrying as the display. That a liquid crystal display panel should be **** (ed), it has the cold cathode tube as the so-called back light, and in order to make that cold cathode tube turn on, the pressure-up inverter in which conversion to the alternating current high voltage of 500Vrms extent is possible is needed for the interior of this liquid crystal display from direct-current low batteries, such as a cell, at the time of 1000 or more Vrmses and a stationary point LGT at the time of lighting initiation. Conventionally, as a transformer for pressure ups of this pressure-up inverter, although the coil transformer has been used, recently, the piezoelectric transformer which performs a pressure up is coming to use it by carrying out electric conversion through mechanical energy. This piezoelectric transformer attracts attention as a small high-voltage power source which the dependency to this load resistance is suitable for the property of the inverter power source of a cold cathode tube by one side, and meets the demand of thin-shape-izing of a liquid crystal display, and efficient-izing although it generally has the property which is not desirable that a pressure-up ratio changes with the magnitude of an output load (load resistance) a lot. An example of the control circuit of such a piezoelectric transformer is explained with reference to drawing 1 .
[0003] Drawing 1 is the block block diagram of the control circuit of the piezoelectric transformer as a conventional example.
[0004] Loads, such as a cold cathode tube by which 101 were connected to the piezoelectric transformer among drawing, and 102 was connected to the output side of a piezoelectric transformer 101, The rectifier circuit which changes into direct current voltage the alternating voltage which produced the resistance Rdet for detection for 103 to detect the current which flows for a load, and 104 in the resistance 103 for detection, 105 compares the electrical potential difference Vri and reference voltage Vref1 after rectification in a rectifier circuit 104. The error amplifying circuit which amplifies the difference which is the comparison result, the armature-voltage control oscillator circuit where 106 outputs an oscillation signal according to the output voltage of the error amplifying circuit 105, and 107 are drive circuits which drive a piezoelectric transformer 101 according to the oscillation signal of the armature-voltage control oscillator circuit 106. Next, actuation of a control circuit equipped with the above-mentioned configuration is explained using drawing 2 .
[0005] Drawing 2 is drawing explaining an example of the frequency characteristics about the output voltage and the load current of a piezoelectric transformer.
[0006] As a piezoelectric transformer 101 is shown in this drawing (above), it has the resonance frequency property of Yamagata which makes a summit resonance frequency which a piezoelectric

transformer 101 has, and generally it is known that the current which flows for a load 102 with the output voltage of a piezoelectric transformer 101 will also serve as the property of the same Yamagata. In addition, the load current is expressed with the load current detection electrical potential difference Vri in this drawing (below). In this property, the control using a right-hand side (the lower right is **) part is explained. If the power source to the control circuit concerned is switched on, the armature-voltage control oscillator circuit 106 will start an oscillation on the initial frequency fa. Since the current is not flowing for a load 102 in that case, the electrical potential difference generated in the detection resistance 103 is zero. Therefore, the error amplifying circuit 105 outputs the negative electrical potential difference which is the result of comparing the load current detection electrical potential difference Vri with reference voltage Vref1 to the armature-voltage control amplifying circuit 106. And since the armature-voltage control circuit 106 shifts the oscillation frequency of an oscillation signal to a low frequency side according to the electrical potential difference, the output voltage of a piezoelectric transformer 101 rises and begins to increase [the load current (load current detection electrical potential difference Vri)] as the frequency shifts to the low frequency side. And a frequency is stabilized in the place where the load current (load current detection electrical potential difference Vri) and reference voltage Vref1 became the same (fb). Even if resonance frequency changes with a temperature change or aging, a frequency can shift according to it and the load current can always be maintained at abbreviation regularity.

[0007] Therefore, according to the control circuit of drawing 1 , frequency control is performed that the load current detection electrical potential difference Vri should be made reference voltage Vref1, and the load current comes to be held by the frequency control at a predetermined value. If a load is used as a cold cathode tube in the control circuit of such a piezoelectric transformer and it is used as a lighting device of a cold cathode tube, since the brightness of a cold cathode tube is proportional to the tube electric current which flows to it, it can attain the important function in which it can hold in predetermined brightness. However, the function (modulated light function) to change the brightness other than the function held in predetermined brightness is required of the lighting device of a cold cathode tube. The technique of adjusting the average tube electric current of a cold cathode tube is proposed by impressing and driving an intermittent pulse voltage to a piezoelectric transformer as one of the technique of the in Japanese Patent Application No. No. 228458 [eight to] by the applicant for this patent to precede. Here, the outline of the technique is explained with reference to drawing 3 and drawing 4 .

[0008] Drawing 3 is the block block diagram of the control circuit of the piezoelectric transformer in which the intensity control of the cold cathode tube as a conventional example is possible.

[0009] Drawing 4 is drawing explaining actuation of the control circuit of the piezoelectric transformer in which the intensity control of the cold cathode tube as a conventional example is possible.

[0010] In drawing 4 , the axis of abscissa shows time amount, respectively, and the axis of ordinate shows the pulse voltage supplied to the drive circuit 107 from the pulse power circuit 108, the oscillation signal outputted from an oscillator circuit 109, and the output voltage of a piezoelectric transformer 101 sequentially from the top, respectively.

[0011] When making brightness small, the pulse voltage which had a certain pulse separation from the pulse power circuit 108 is supplied to the drive circuit 107. Here, let the High period (Thigh) of the pulse voltage supplied to the drive circuit 107 from the pulse power circuit 108 be a sufficiently larger thing than the period of the oscillation signal acquired from an oscillator circuit 109 (for example, the frequency of a pulse voltage sets the frequency of an oscillation signal to about hundreds of Hz to 100kHz). When pulse-like supply voltage is a Low period (Tlow) like illustration, since the drive circuit 107 cannot drive a piezoelectric transformer 101, output voltage is zero. On the other hand, since an electrical potential difference is impressed to the drive circuit 107 and when a pulse voltage is a High period (Thigh) operates, a piezoelectric transformer 101 is driven and occurs [output voltage]. By repeating this actuation, the average of the tube electric current (load current) which flows to a cold cathode tube (load 2) can become small, and brightness can be reduced. In this case, it is still shorter in the High period in a pulse voltage, or if a Low period is lengthened further, the average tube electric

current which flows to a cold cathode tube will become smaller, and brightness will fall. For human being's vision, it is for the after-image in a High period to remain.

[0012]

[Problem(s) to be Solved by the Invention] However, even if it is going to include in the control circuit of the piezoelectric transformer which showed the technique of drawing 3 to drawing 1 and is going to carry out the load of the modulated light function, a modulated light function is not obtained. Because, if the average tube electric current by intermittent oscillation is decreased in order to make the light modulate, since the load current detection electrical potential difference Vri will become smaller than reference voltage Vref, the oscillation frequency of the armature-voltage control oscillator circuit 106 shifts to a low frequency side, it works in the direction to which the drive circuit 107 makes the tube electric current increase, and the average tube electric current is for not changing after all. That is, it is because a "modulated light function" stops functioning by "the function which maintains the tube electric current at abbreviation regularity" which the control circuit of a piezoelectric transformer has.

[0013] Then, this invention aims at offer of the control circuit of the piezoelectric transformer in which coexistence with the function which maintains at abbreviation regularity the tube electric current of the cold cathode tube which is a load, and the wide range brilliance-control function by intermittent oscillation is possible, and putting out lights and re-lighting especially by the brilliance control are possible, and its control approach.

[0014]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the control circuit of the piezoelectric transformer of this invention is characterized by the following configurations.

[0015] Namely, an oscillation means to generate an oscillation signal according to control voltage and the driving means which drives a piezoelectric transformer with the alternating voltage generated according to the oscillation signal from the oscillation means, The control means which controls the oscillation frequency of this oscillation means that the load current of the load connected to the output side of said piezoelectric transformer should be detected, and the load current should be made to abbreviation regularity, It is the control circuit of preparation **************, and when the oscillation frequency of said oscillation means shifts from a predetermined control range, it is characterized by having the sweep means which carries out the sweep of the oscillation frequency to predetermined frequency.

[0016] Moreover, it is good to contain said predetermined control range in the frequency characteristics by the side of high frequency preferably rather than the frequency in which the output voltage of said piezoelectric transformer takes the maximal value among the resonance characteristics which said control means is using by characterizing said predetermined frequency by being the frequency the output voltage in the resonance characteristic which said control means is using among the resonance characteristics which said piezoelectric transformer has indicates the minimal value to be, for example, and to include said predetermined frequency.

[0017] Furthermore, the pulse signal for driving said piezoelectric transformer intermittently preferably is generated, it has an intermittent oscillation means to supply the pulse signal to said driving means, and the intermittent oscillation means is good to include the adjustment device which adjusts said load current by adjusting the duty ratio of the pulse signal to generate.

[0018] Moreover, it has a control voltage detection means to detect the control voltage of said oscillation means, for example, and said sweep means is good to detect that the oscillation frequency of said oscillation means shifted from said predetermined control range based on the output of this control voltage detection means.

[0019] Preferably, further, the output of said load current detection means is sampled synchronizing with said pulse voltage, and it is characterized by having a sample hold means to hold, and a control voltage generation means to generate the control voltage of said oscillation means based on the output from the sample hold means. Thereby, even if the intermission of the driving means is carried out by intermittent oscillation, frequency control carried out to abbreviation regularity of the load current is realized.

[0020] Or in order to attain the above-mentioned purpose, the control approach of the piezoelectric

transformer of this invention is characterized by the following configurations.
[0021] That is, it is the control approach of the piezoelectric transformer which controls this oscillation frequency that an oscillation signal should be generated according to control voltage, a piezoelectric transformer should be driven with the alternating voltage generated according to the oscillation signal, the load current of the load connected to the output side of the piezoelectric transformer should be detected, and the load current should be made to abbreviation regularity, and when said oscillation frequency shifts from a predetermined control range, it is characterized by to carry out the sweep of the oscillation frequency to predetermined frequency.
[0022] Moreover, it is good to contain said predetermined control range in the frequency characteristics by the side of high frequency preferably rather than the frequency in which the output voltage of said piezoelectric transformer takes the maximal value among the resonance characteristics currently used for said control approach by being characterized, for example by the output voltage in the resonance characteristic which said piezoelectric transformer is using for said control approach among the resonance characteristics which it has making said predetermined frequency the frequency which shows the minimal value, and to include said predetermined frequency.
[0023]
[Embodiment of the Invention]
The 1st operation gestalt of the control circuit of the piezoelectric transformer concerning this invention is explained with reference to a drawing below [the 1st operation gestalt].
[0024] Drawing 5 is the block block diagram of the control circuit of the piezoelectric transformer as 1st operation gestalt of this invention.
[0025] Loads, such as a cold cathode tube by which one was connected to the piezoelectric transformer among drawing, and 2 was connected to the output side of a piezoelectric transformer 1, The rectifier circuit which changes into direct current voltage the alternating voltage which produced the resistance Rdet for detection for 3 to detect the current which flows for a load, and 4 in the resistance 3 for detection, The sample hold circuit where 12 holds the output voltage (following and load current detection electrical potential difference Vri) of a rectifier circuit 4 according to the signal from the pulse power circuit 8, The error amplifying circuit which 5 compares the output voltage and reference voltage Vref1 of a sample hold circuit 12, and amplifies the difference, The armature-voltage control oscillator circuit where 6 outputs an oscillation signal according to the output voltage of the error amplifying circuit 5, and 7 are drive circuits which drive a piezoelectric transformer 1 according to the oscillation signal of the armature-voltage control oscillator circuit 6. Moreover, 8 is a pulse power circuit, it generates the supply voltage of the shape of a pulse supplied to the drive circuit 7 from input voltage Vi so that it may change the brightness of a cold cathode tube (load 2), and it controls the pulse width and spacing in supply voltage of the shape of the pulse.
[0026] Moreover, a sample hold circuit 12 consists of buffer 12a, capacitor 12b for charge, and switching element 12c, as shown in this drawing.
[0027] Drawing 6 is drawing explaining the configuration of the pulse power circuit as 1st operation gestalt of this invention.
[0028] The pulse power circuit 8 outputs a pulse voltage to the drive circuit 7 ON / by making it turn off among drawing according to the signal outputted by switching element 8b, such as for example, MOS-FET (MOS mold field-effect transistor), from pulse oscillator-circuit 8a in the input voltage Vi which is direct current voltage. Moreover, the signal outputted from pulse oscillator-circuit 8a is supplied also to switching element 12c of a sample hold circuit 12. Therefore, it is constituted so that the switching rate of switching element 8b and switching element 12c may be controlled by the signal outputted from pulse oscillator-circuit 8a.
[0029] Next, actuation of the control circuit of a piezoelectric transformer equipped with the above configurations is explained.
[0030] When first making brightness into max, the supply voltage of the shape of a pulse supplied from the pulse power circuit 8 turns into continuous direct current voltage, and switching element 12c will be in the condition of having always closed in a sample hold circuit 12. Therefore, since it is the same

control as the circuit which changed into the condition that there is no sample hold circuit 12, and was explained with the conventional technique, explanation is omitted.
[0031] Next, pulse oscillator-circuit 8a is adjusted in order to lower brightness, pulse-like supply voltage is supplied to the drive circuit 7 from the pulse power circuit 8, and actuation in case the relation drive of the piezoelectric transformer 1 is carried out is explained.
[0032] When switching element 8b of the pulse power circuit 8 interior closes and the electrical potential difference Vi is now supplied to the drive circuit 4, by the driver voltage from the drive circuit 7, a piezoelectric transformer 1 is driven and the tube electric current flows to a cold cathode tube (oscillation period). since the signal from pulse oscillator-circuit 8a inside a pulse power circuit is inputted into the control terminal of switching element 12c in a sample hold circuit 12 at this time, it has closed as well as switching element 8b of the pulse power circuit 8 interior, and the load current detection electrical potential difference Vri detected by the detection resistance 3 and the rectifier circuit 4 is charged by capacitor 12b -- it is both outputted to the error amplifying circuit 5 through buffer 12a. Therefore, from the error amplifying circuit 5, the electrical potential difference according to the difference of the load current detection electrical potential difference Vri and reference voltage Vref1 is outputted, and a piezoelectric transformer 1 drives as a result.
[0033] Next, since a piezoelectric transformer 1 does not drive when switching element 8b of the pulse power circuit 8 interior opens and the electrical potential difference is not supplied to the drive circuit 4, the tube electric current does not flow to a cold cathode tube (idle period). Since switching element 12c of the sample hold circuit 12 interior is open at this time, it is not influenced by the load current detection electrical potential difference Vri from a rectifier circuit 4, but the electrical potential difference Vri charged while switching element 12c had closed to charged-capacitor 12b of the sample hold circuit 12 interior, i.e., the load current detection electrical potential difference at the time of lighting, is outputted to the error amplifying circuit 5.
[0034] Therefore, also in an idle period, since it becomes controllable [an oscillation frequency] using the electrical potential difference charged with the load current detection electrical potential difference Vri of an oscillation period, the drive condition of the piezoelectric transformer 1 in an oscillation period will be held. Moreover, since the average tube electric current can be changed by adjusting pulse oscillator-circuit 8a and changing Thigh or Tlow in order to modulate the light of a cold cathode tube, it also becomes possible to change the brightness of a cold cathode tube as a result.
[0035] Since according to the control circuit of drawing 5 explained above the electrical potential difference to the armature-voltage control oscillator circuit equivalent to the tube electric current of an oscillation period can be held by control of a sample hold circuit when a piezoelectric transformer is driven intermittently that the light of a cold cathode tube should be modulated, Since the average tube electric current can be adjusted by attaining maintenance of the drive condition of the drive circuit in this oscillation period, and changing the die length of an oscillation period or an idle period even if it is an idle period, adjustment of the brightness of a cold cathode tube also becomes possible.
[0036] However, according to above-mentioned technique, relative luminance is changeable in about 10% - 100% of range by adjusting the oscillation period (duty) of the pulse power circuit 8 to about 20% - 100%, but it is impossible to adjust relative luminance to 0%. Since the tube electric current will serve as zero in an oscillation period if the drive of 0%1, i.e., a piezoelectric transformer, is stopped if the reason is explained, the sweep of the frequency is carried out by the frequency control of the armature-voltage control oscillator circuit 8 which is going to hold the tube electric current to a predetermined value to a lower limit (for example, near the left end of the property of Yamagata of drawing 2). Since it is greatly shifted from resonance frequency, it will become impossible for a piezoelectric transformer 1 to generate the high voltage required for lighting initiation of a cold cathode tube, and to re-turn it on in a lower cut off frequency. Moreover, since the frequency control which makes the tube electric current abbreviation regularity on the left-hand side of the resonance characteristic serves as positive feedback even if it re-switches on the light, normal control is not performed. That is, after adjusting brightness to 0%, the problem that it cannot return to normal actuation arises. Then, the 2nd operation gestalt which has solved this problem is explained below.

[0037] [Operation gestalt of ** 2nd] drawing 7 is the block block diagram of the control circuit of the piezoelectric transformer as 2nd operation gestalt of this invention, in this drawing, about the part of the same circuitry as the 1st operation gestalt (drawing 5), the same reference number is attached and explanation is omitted.
[0038] Nine are an electrical-potential-difference comparator circuit which compares the control voltage Vctr and reference voltage Vref2 which are outputted from the error amplifying circuit 5, and outputs the signal of High or Low according to the comparison result among drawing. Although armature-voltage control oscillator-circuit 6A is the armature-voltage control oscillator circuit 6 of drawing 5 , and an armature-voltage control oscillator circuit which outputs an oscillation signal to the drive circuit 7 similarly according to the output voltage of the error amplifying circuit 5, the strobe terminal P which makes the frequency of the oscillation signal which armature-voltage control oscillator-circuit 6A outputs upper limited frequency (initial frequency) is formed further. Hereafter, the configuration and actuation of armature-voltage control oscillator-circuit 6A are explained.
[0039] Drawing 8 is drawing showing the configuration of the armature-voltage control oscillator circuit as 2nd operation gestalt of this invention.
[0040] The output voltage and the internal electrical potential difference Vid of the error amplifying circuit 5 are inputted into switching element 6a among drawing. Here, since the oscillation signal to the drive circuit 7 is fixed to upper limited frequency (initial frequency), the internal electrical potential difference Vid is used. These inputs are switched by switching element 6a according to the condition of the signal inputted into the strobe terminal P, are inputted into V/F converter 6b, and are changed into a frequency.
[0041] In this operation gestalt, armature-voltage control oscillator-circuit 6A chooses the output voltage of the error amplifying circuit 5, when "High" is inputted into the strobe terminal P, and it outputs the signal of the frequency according to the output voltage to the drive circuit 7. Hereafter, this control action of a series of is called "usual modulated light actuation." On the other hand, when "Low" is inputted into the strobe terminal P, armature-voltage control oscillator-circuit 6A chooses the internal electrical potential difference Vid, and outputs the signal of the frequency according to the internal electrical potential difference Vid to the drive circuit 7.
[0042] Here, to upper limited frequency, a piezoelectric transformer 1 is in a control range predetermined [by the side of the high frequency in the resonance characteristic which the control circuit concerned is using for control] among the resonance characteristics which it has, and it is desirable to set it as the frequency output voltage indicates the minimal value (for example, fa of drawing 2) to be. This is because it goes into the range of the resonance characteristic of next Yamagata and normal control becomes impossible, if the control circuit concerned adopts even a bigger frequency than the upper limited frequency in the resonance characteristic currently used for modulated light control, since a piezoelectric transformer generally has resonance frequency for every integral multiple of the resonant frequency.
[0043] In this operation gestalt, since the same control as the control circuit of drawing 5 mentioned above is made when the oscillation period of the pulse power circuit 8 is 100% [20% -] of abbreviation, the control voltage Vctr of an oscillation frequency is larger from resonance frequency than reference voltage Vref2 a RF side. Therefore, "High" is outputted from the electrical-potential-difference comparator circuit 9, and the above-mentioned usual modulated light actuation is performed in the range whose relative luminance is about 10% - 100%.
[0044] In this case, if the oscillation period of the pulse power circuit 8 is adjusted smaller than 20%, as the last of the 1st operation gestalt mentioned above explained, modulated light control of a cold cathode tube (load) 2 will serve as the impossible (putting-out-lights condition).
[0045] Next, the oscillation period of the pulse power circuit 8 is set up to 0%, and a cold cathode tube (load) 2 is explained with reference to drawing 9 about the actuation made to re-turn on from a putting-out-lights condition.
[0046] Drawing 9 is drawing explaining actuation of the control circuit of the piezoelectric transformer as 2nd operation gestalt of this invention, and shows the property of control voltage Vctr to the load

current detection electrical-potential-difference Vri list to the frequency of the oscillation signal by armature-voltage control oscillator-circuit 6A.

[0047] In this operation gestalt, where an oscillation period is set up to 0% in pulse oscillator-circuit 8a of the pulse power circuit 8, since a piezoelectric transformer 1 is not driven, as for the output voltage of a piezoelectric transformer 1, abbreviation zero are shown, and the load current serves as abbreviation zero. Therefore, in the error amplifying circuit 5, since the load current detection electrical potential difference Vri becomes smaller than reference voltage Vref1, the control voltage Vctr which the error amplifying circuit 5 outputs becomes small, and shifts an oscillation frequency to a low frequency side exceeding resonance frequency. And if control voltage Vctr becomes smaller than reference voltage Vref2, when the electrical-potential-difference comparator circuit 9 outputs "Low", armature-voltage control oscillator-circuit 6A will output the oscillation signal for setting up the upper limited frequency mentioned above.

[0048] Moreover, even if it returns the frequency of an oscillation signal to upper limited frequency fa by armature-voltage control oscillator-circuit 6A at this time, in order for the oscillation frequency of a piezoelectric transformer 1 to exceed resonance frequency and to shift to a low frequency side with the output characteristics of the piezoelectric transformer 1 as shown in drawing 2 , the output voltage of a piezoelectric transformer 1 declines. Therefore, if the control voltage Vctr of the error amplifying circuit 5 becomes smaller than reference voltage Vref2 in the condition that the oscillation period was set up to 0%, in pulse oscillator-circuit 8a, actuation that armature-voltage control oscillator-circuit 6A returns the frequency of an oscillation signal to upper limited frequency fa again will be repeated (refer to drawing 9).

[0049] And if the oscillation period is extended from this condition, i.e., the condition of 0% of oscillation periods, by adjusting pulse oscillator-circuit 8a in the pulse power circuit 8, output voltage will occur in the output of a piezoelectric transformer 1, and, as a result, the load current will flow and light up to a cold cathode tube (load 2). And if the load current detection electrical potential difference Vri becomes larger than reference voltage Vref1, armature-voltage control oscillator-circuit 6A will return to the above-mentioned usual modulated light actuation.

[0050] Thus, according to this operation gestalt mentioned above, the oscillation period of a pulse power circuit serves as compatible with the brilliance-control function in 0% - 100% of range a function which maintains at abbreviation regularity the tube electric current of the cold cathode tube which is a load, and an oscillation period can also ensure now re-lighting of the cold cathode tube from 0%.

[0051] <Modification of 2nd operation gestalt> drawing 10 is the block block diagram of the control circuit of the piezoelectric transformer as a modification 1 of the 2nd operation gestalt of this invention.

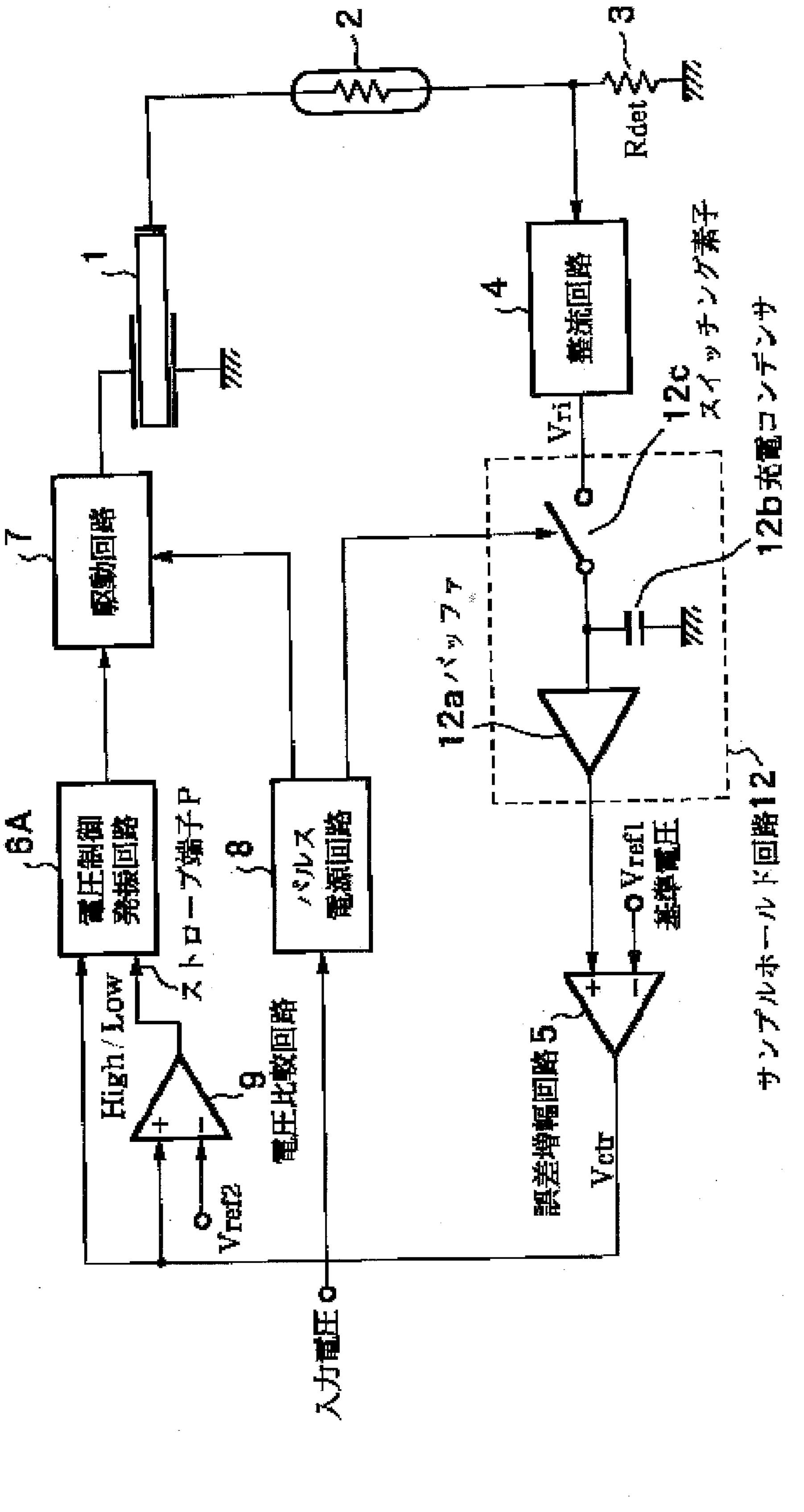
[0052] In this drawing, if a different configuration from above-mentioned drawing 7 is explained, the armature-voltage control oscillator circuit 6 is not equipped with a strobe terminal, but is the same as drawing 5 . Instead, error amplifying-circuit 5A is equipped with the strobe terminal P which changes the reference voltage inputted into amplifying-circuit 5a at amplifying-circuit 5a, switching element 5b, and a list through switching element 5b to any of reference voltages Vref1 or Vref3 they are.

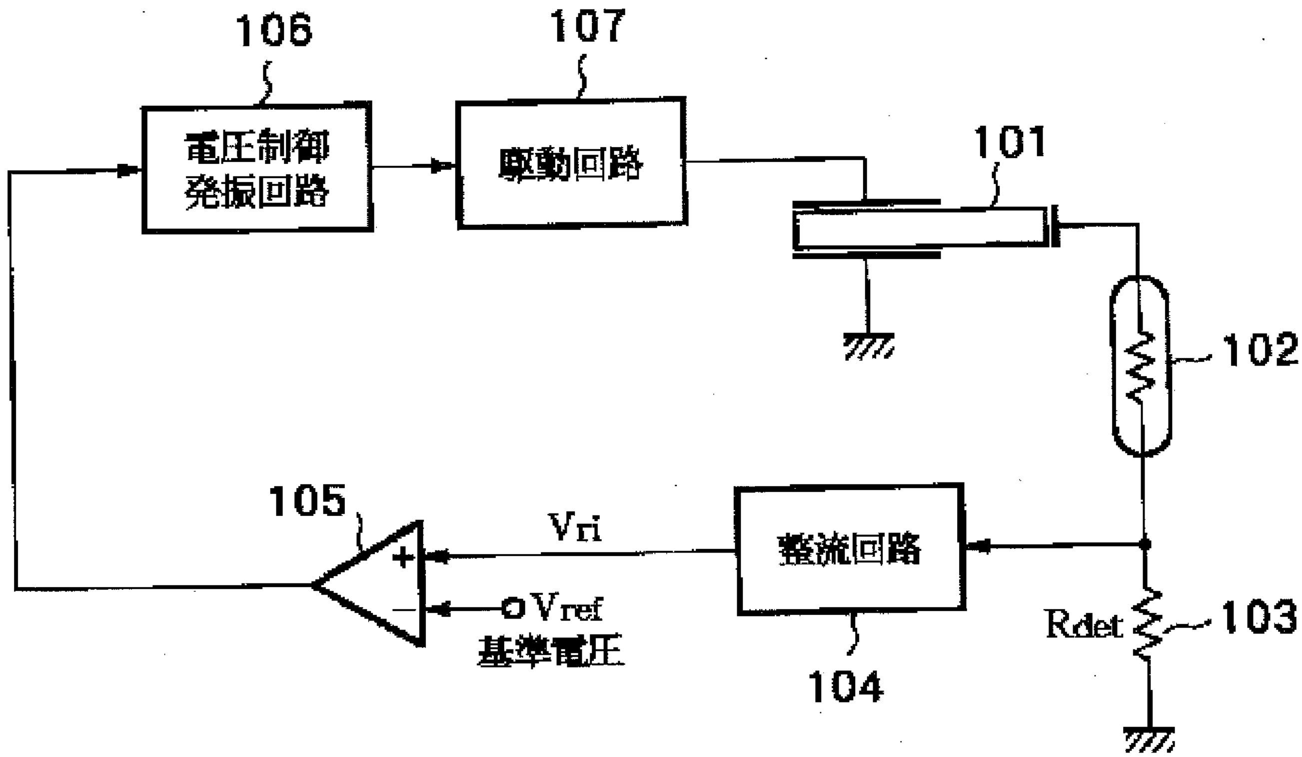
[0053] In this modification, when the control voltage Vctr inputted into the armature-voltage control oscillator circuit 6 is larger than reference voltage Vref2, the electrical-potential-difference comparator circuit 9 outputs "High", and, thereby, reference voltage Vref1 is inputted into the negative input terminal of error amplifying-circuit 5A. Since the actuation when being inputted into error amplifying-circuit 5A serves as the same control as the usual modulated light actuation in the operation gestalt (drawing 7) mentioned above, reference voltage Vref1 omits explanation.

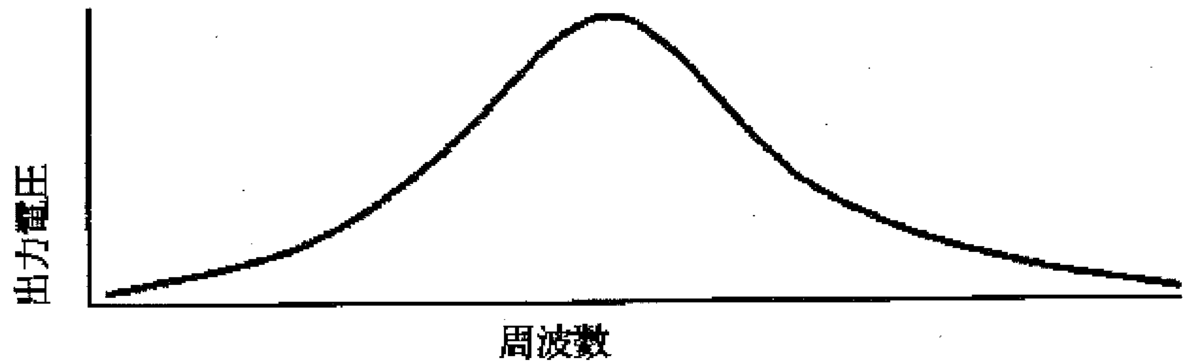
[0054] On the other hand, when an oscillation period is set as this modification to 0% in pulse oscillator-circuit 8a when ** and control voltage Vctr are smaller than reference voltage Vref2, and a cold cathode tube 2 puts out the light as a result, the electrical-potential-difference comparator circuit 9 outputs "Low", and, thereby, a negative electrical potential difference is inputted into the negative input terminal of error amplifying-circuit 5A as reference voltage Vref3. Such in a condition, since the load current detection electrical potential difference Vri becomes always larger than reference voltage Vref3, error amplifying-circuit 5A of this modification outputs an electrical potential difference with the armature-

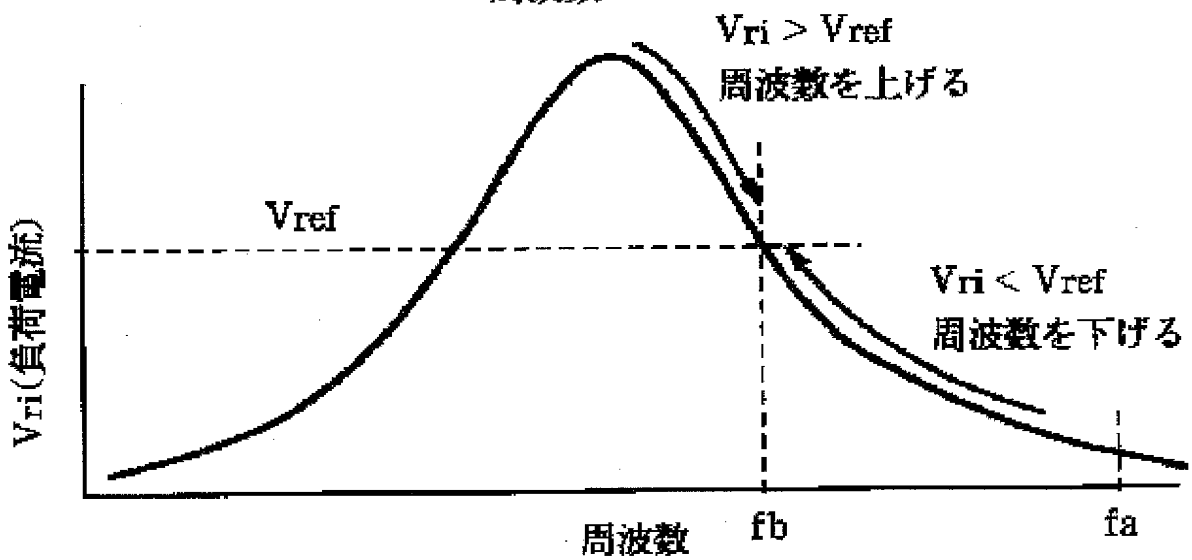
voltage control oscillator circuit 6 able to return the frequency of an oscillation signal to upper limited frequency fa as control voltage Vctr. Also by such circuitry, the same effectiveness as the control circuit of drawing 7 mentioned above is acquired.
[0055] Furthermore, the drive circuit 7 in above-mentioned drawing 7 is explained with reference to drawing 11 as a modification 2 of this operation gestalt about the case where it considers as the so-called drive circuit of the bridge type constituted with the transistor.
[0056] Drawing 11 is the block block diagram of the control circuit of the piezoelectric transformer as a modification 2 of the 2nd operation gestalt of this invention.
[0057] In the case of above-mentioned drawing 7 , the intermittent drive of drive circuit 7 the very thing was carried out by the pulse power circuit 8, and it carried out the intermittent drive of the piezoelectric transformer 1. On the other hand, in this modification, the circuit of a half bridge type is adopted as the drive circuit 7, and it reaches pulse oscillator-circuit 13, and (AND) a circuit 15 is used, and the intermittent drive of a piezoelectric transformer 1 is realized.
[0058] In drawing 11 , the pulse oscillator circuit 13 is equipped with the non-illustrated adjustment device, and adjustment of the duty ratio of the pulse signal to output is possible. AND circuit 15 outputs the AND signal of the pulse signal which the pulse oscillator circuit 13 outputs, and the oscillation signal which armature-voltage control oscillator-circuit 6A outputs.
[0059] The drive circuit 7 of this modification consists of P type transistor (FET: field-effect transistor) 7a and N type transistor (FET) 7b which were connected to the half bridge type.
[0060] Two transistors 7a and 7b switch to this drive circuit 7 by turns by inputting the AND signal from AND circuit 15 into a high side, and inputting the oscillation signal which armature-voltage control oscillator-circuit 6A outputs to a low side. Therefore, although input voltage Vi is inputted into the drive circuit 7, the driver voltage (alternating voltage) which makes input voltage Vi the amplitude is intermittently impressed to a piezoelectric transformer 1 by switching operation with two transistors 7a and 7b. Moreover, the pulse signal which the pulse oscillator circuit 13 outputs is outputted to switching element 12c of a sample hold circuit 12, and controls a switch of switching element 12c like the operation gestalt of drawing 7 synchronizing with the pulse signal.
[0061] Since it is the same as that of the operation gestalt of drawing 7 except the above-mentioned configuration, the same reference number is attached and detailed explanation is omitted. Also by such circuitry, the same effectiveness as the control circuit of drawing 7 mentioned above is acquired.
[0062] In addition, although the modification 2 explained based on the control circuit of drawing 7 , it cannot be overemphasized that the drive circuit 7 of a half bridge type may be adopted also about the control circuit of drawing 10 , and the pulse oscillator circuit 13 and AND circuit 15 may be used instead of the pulse power circuit 8. Moreover, the drive circuit 7 is not restricted to a half bridge type, and it cannot be overemphasized that it is good also as a circuit of a full bridge type.
[0063]
[Effect of the Invention] As explained above, according to this invention, offer of the control circuit of the piezoelectric transformer in which coexistence with the function which maintains at abbreviation regularity the tube electric current of the cold cathode tube which is a load, and the wide range brilliance-control function by intermittent oscillation is possible, and putting out lights and re-lighting especially by the brilliance control are possible, and its control approach is realized.
[0064] That is, the brilliance control [in / in the oscillation period of a pulse power circuit / 0% - 100% of range] was realized, and when it was detected that the oscillation frequency shifted from the predetermined control range, it was made to return the oscillation frequency of an armature-voltage control oscillator circuit to a upper limit. If an oscillation period is adjusted and it enlarges from 0% by this, the frequency control which makes the tube electric current a predetermined value is started again, and a cold cathode tube can be re-turned on.
[0065]

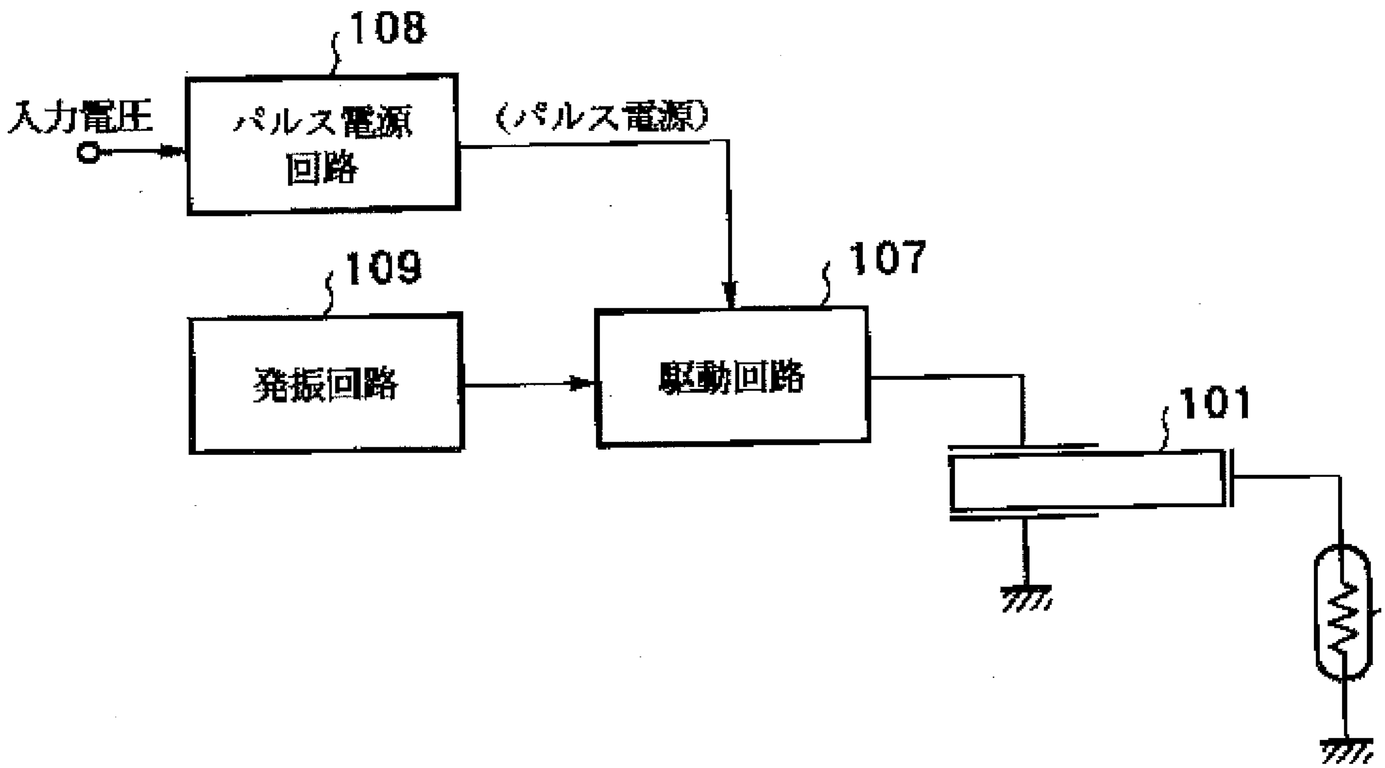
[Translation done.]

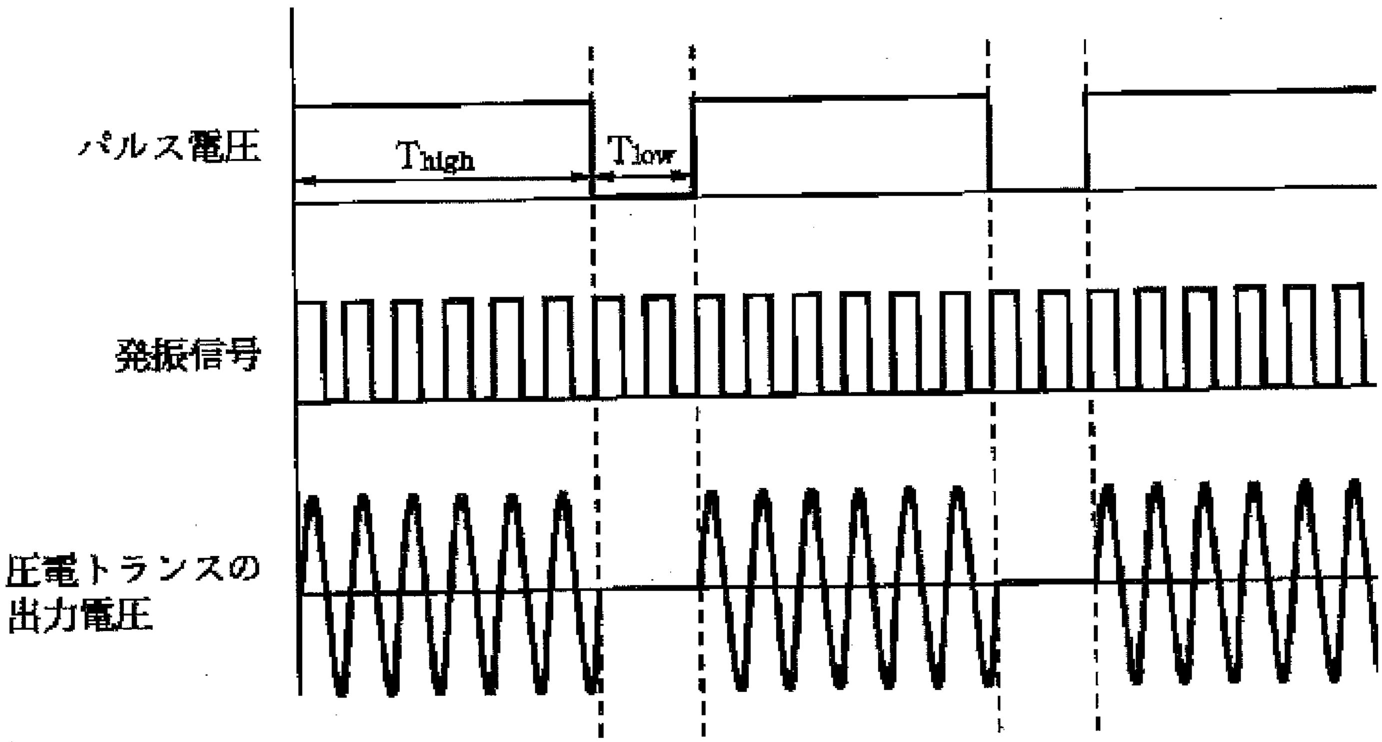

1
2
3
Rdet
4
整流回路
Vri
12c
スイッチング素子
12b充電コンデンサ
12aバッファ
サンプルホールド回路12
7
駆動回路
6A
電圧制御
発振回路
ストローブ端子P
8
パルス
電源回路
Vref1
基準電圧
High / Low
9
電圧比較回路
Vref2
誤差増幅回路5
Vctr
入力電圧

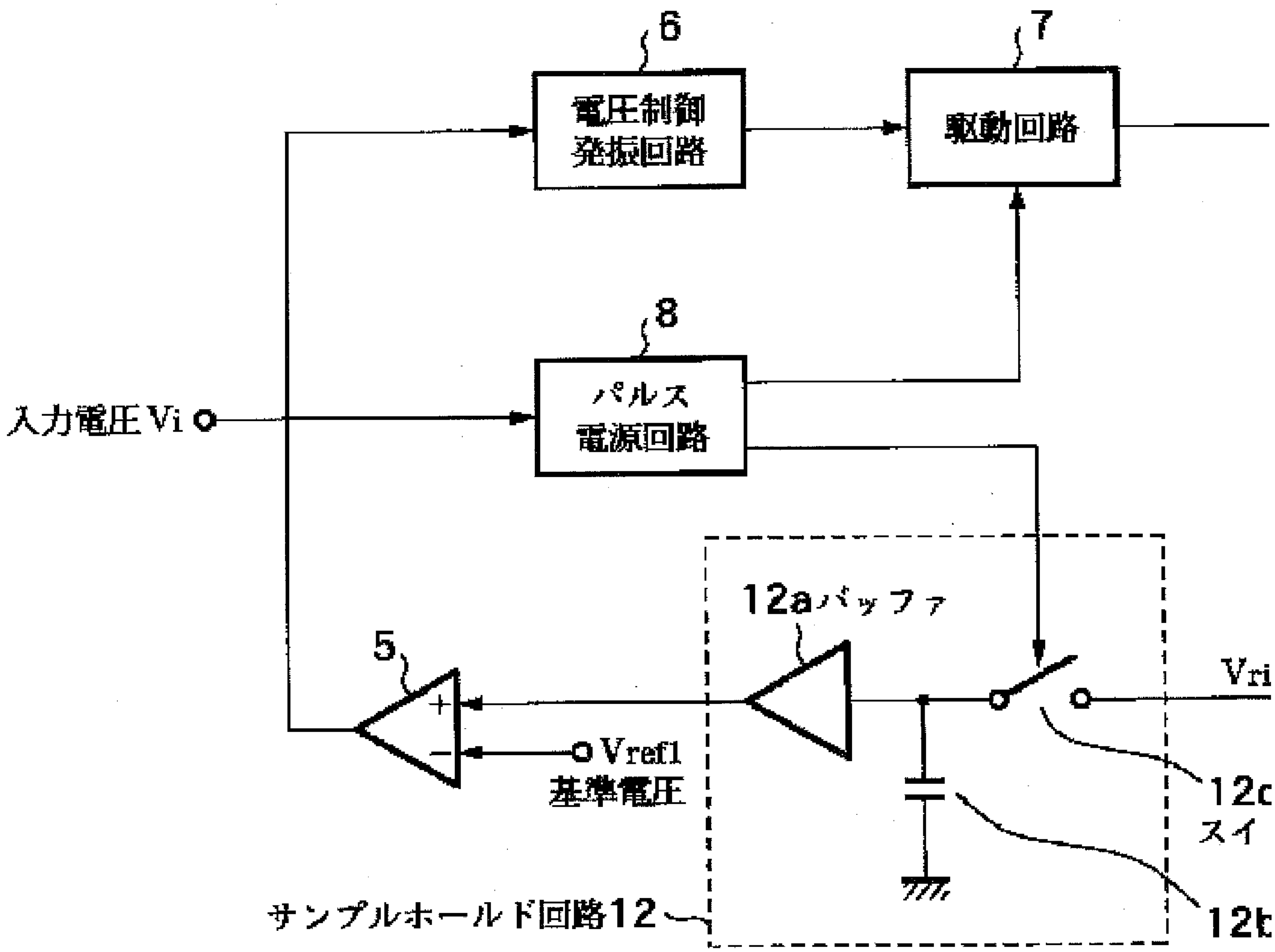

106
107
電圧制御
発振回路
駆動回路
101
102
105
Vri
整流回路
Vref
基準電圧
Rdet
103
104

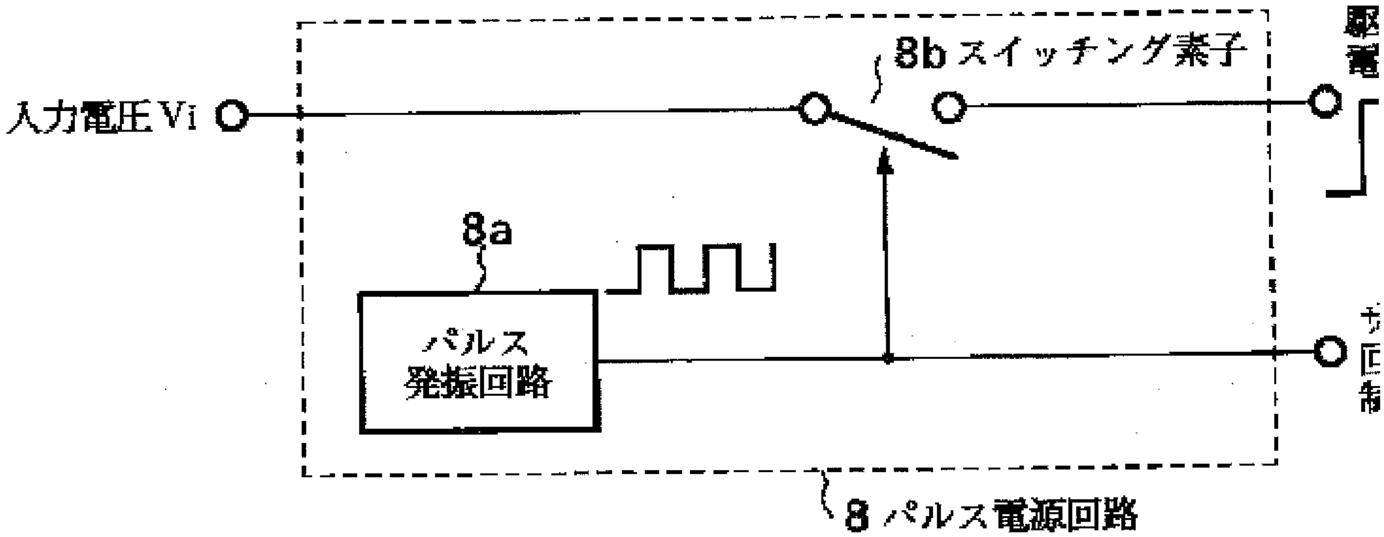

出力電圧
周波数

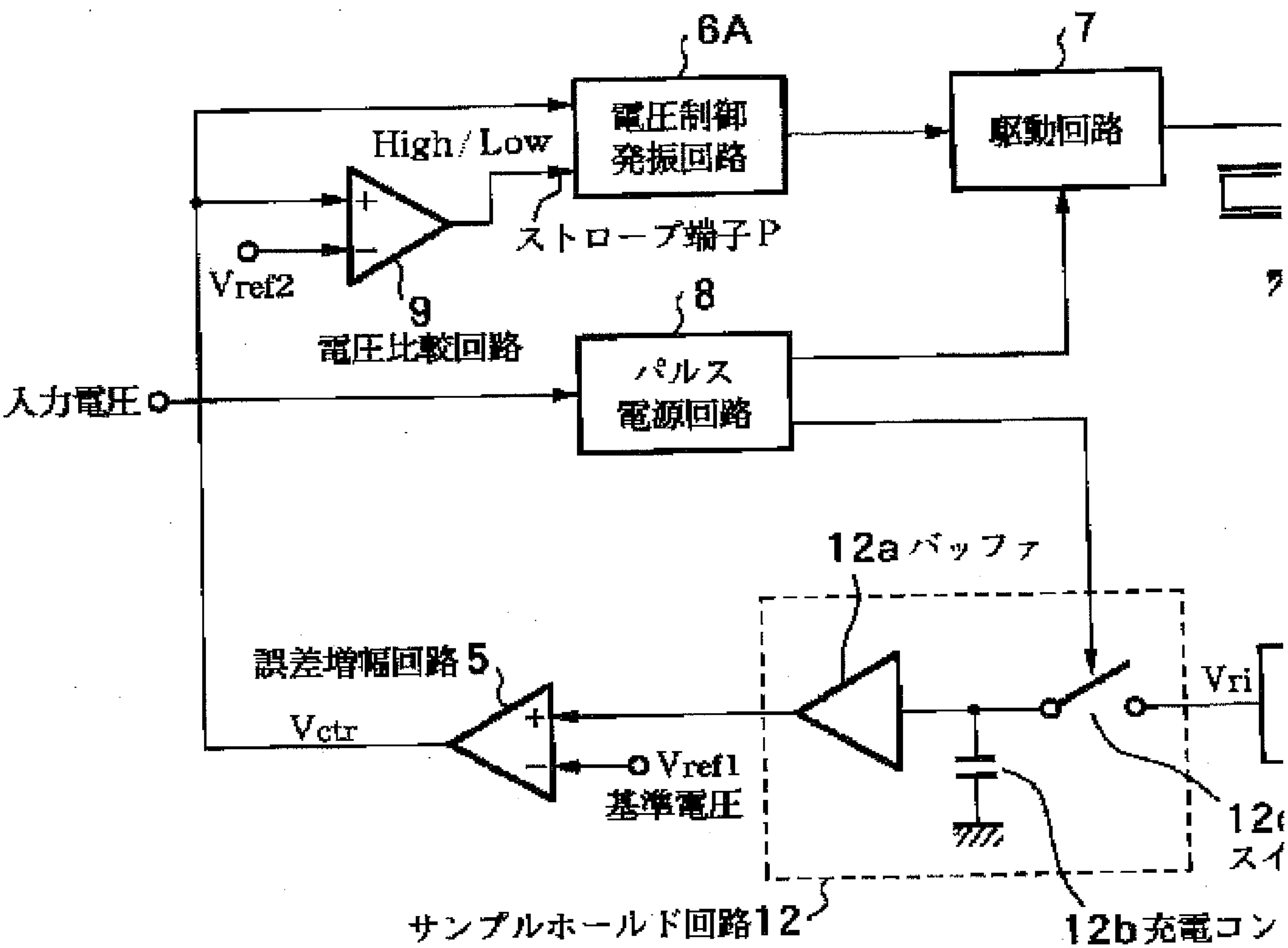

Vri > Vref
周波数を上げる
Vref
Vri < Vref
周波数を下げる
Vri(負荷電流)
周波数
fb
fa

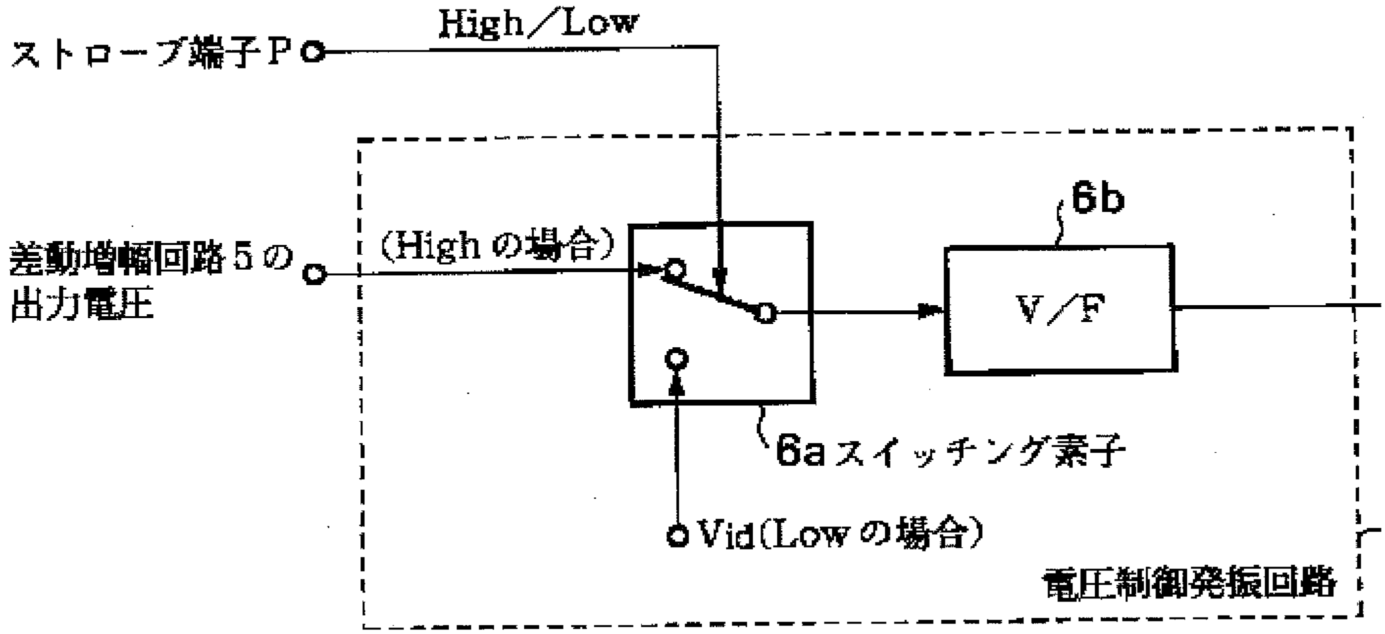

108
入力電圧
パルス電源回路
（パルス電源）
109
発振回路
107
駆動回路
101


パルス電圧
Thigh
Tlow
発振信号
圧電トランスの
出力電圧

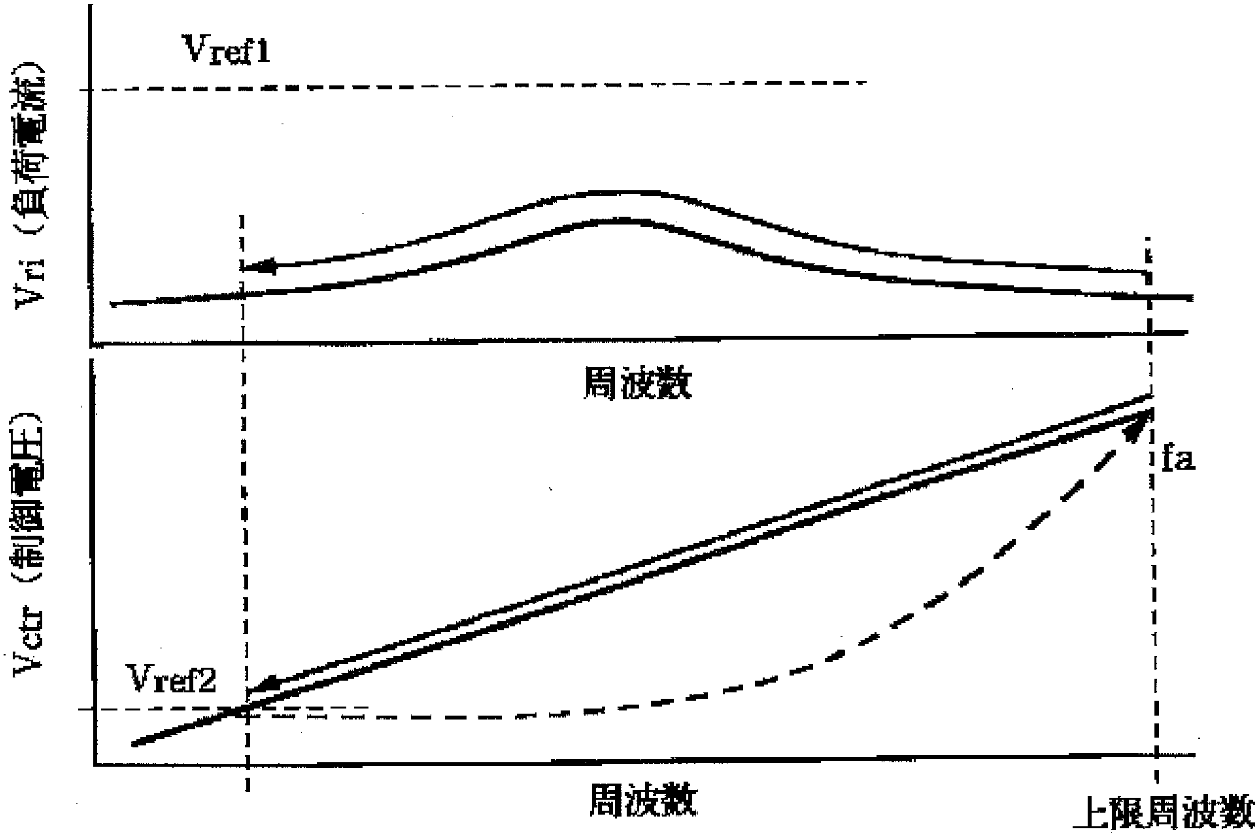

6
電圧制御
発振回路
7
駆動回路
8
パルス
電源回路
入力電圧Vi
12aバッファ
5
Vri
Vref1
基準電圧
12c
スイ
12b
サンプルホールド回路12

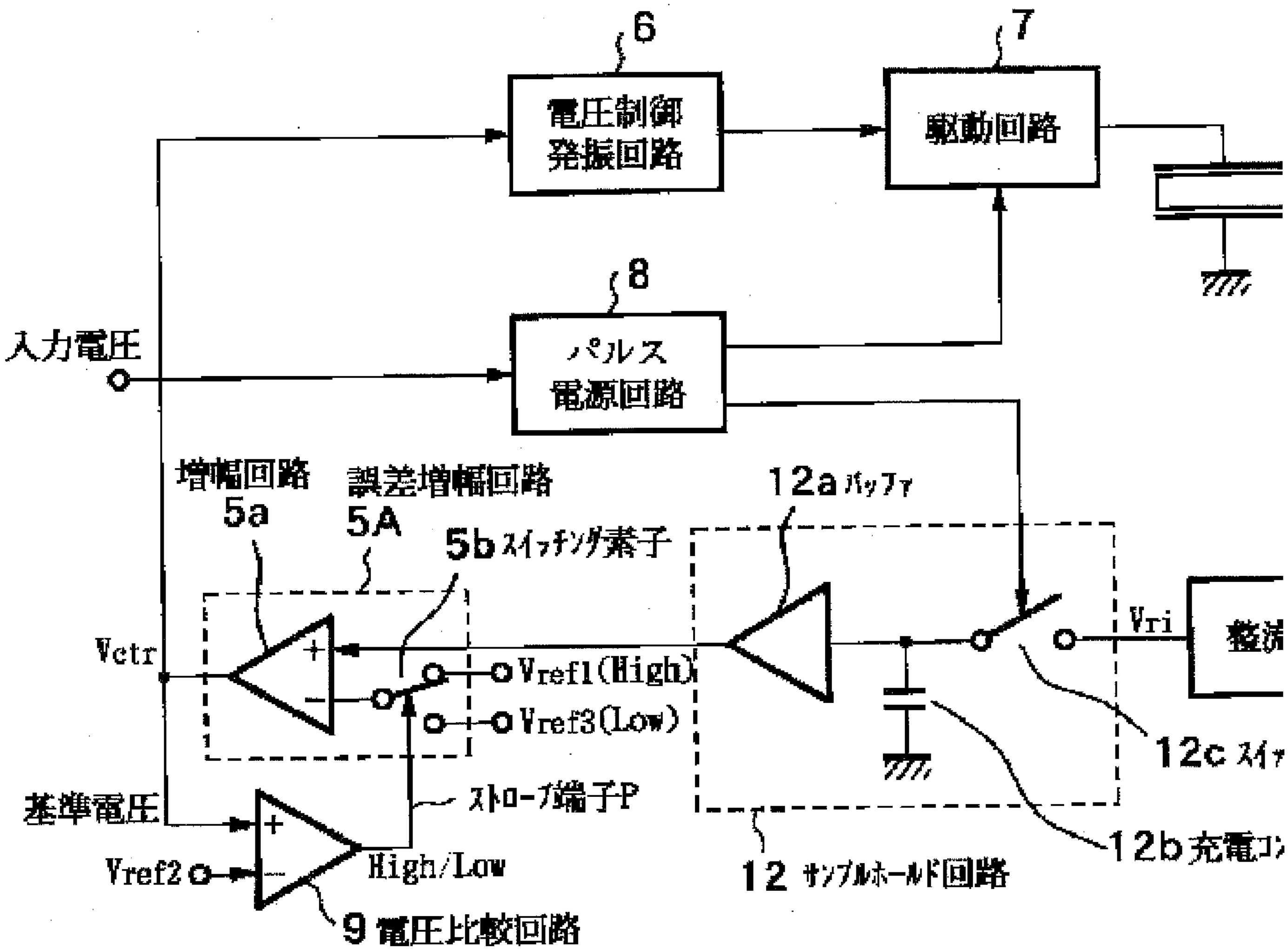

入力電圧Vi
8b スイッチング素子
8a
パルス
発振回路
8 パルス電源回路

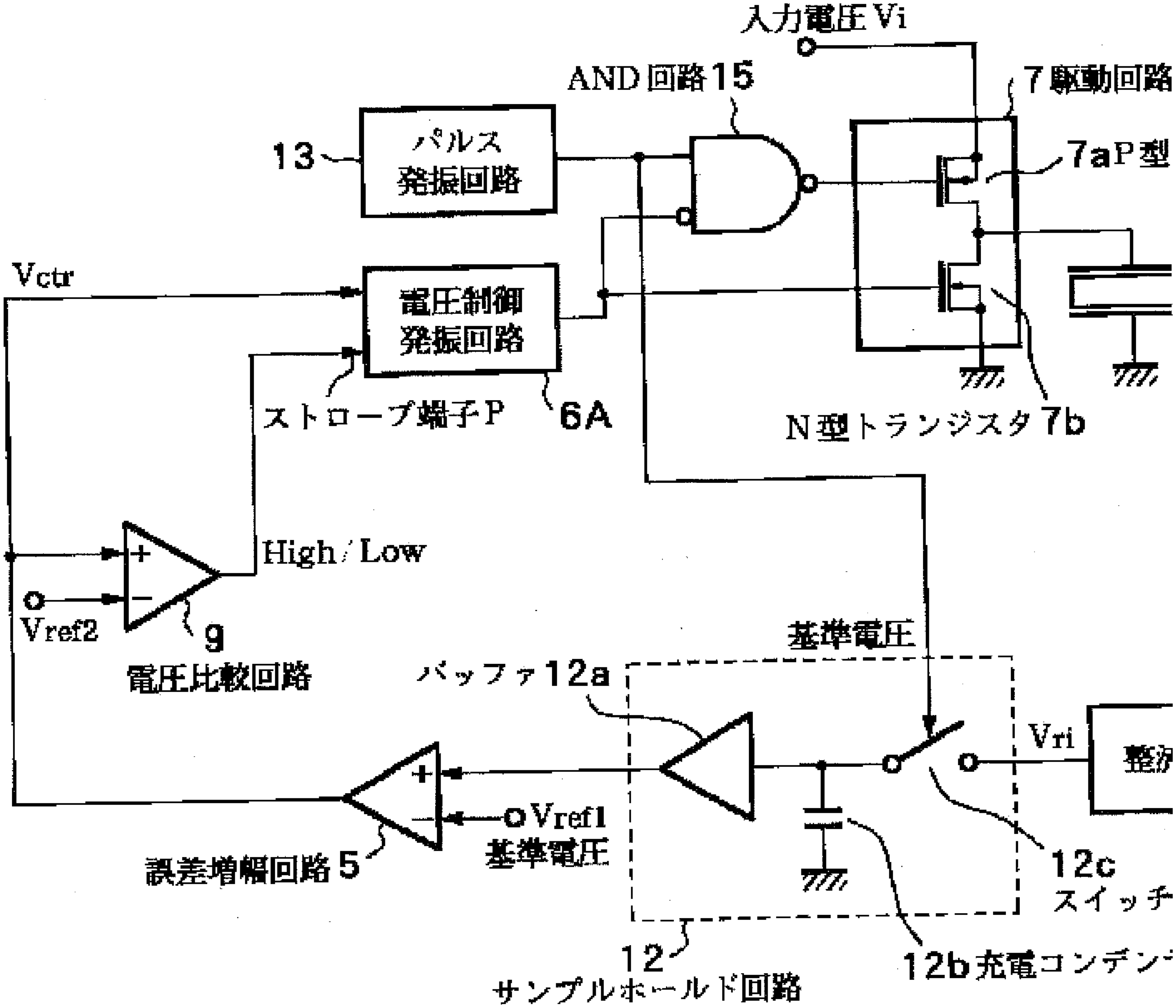

6A
7
電圧制御
発振回路
駆動回路
High / Low
ストローブ端子P
Vref2
9
電圧比較回路
8
パルス
電源回路
入力電圧
12a バッファ
誤差増幅回路 5
Vri
Vctr
Vref1
基準電圧
サンプルホールド回路12
12b 充電コン



High／Low
ストローブ端子P
差動増幅回路５の
出力電圧
（Highの場合）
6b
V／F
6aスイッチング素子
Vid（Lowの場合）
電圧制御発振回路


Vref1
Vri（負荷電流）
周波数
Vctr（制御電圧）
Vref2
fa
周波数
上限周波数


6
電圧制御
発振回路
7
駆動回路
8
パルス
電源回路
入力電圧
増幅回路
5a
誤差増幅回路
5A
5b スイッチング素子
12a バッファ
Vctr
Vref1(High)
Vref3(Low)
Vri
整流
12c スイッ
基準電圧
ストローブ端子P
12b 充電コン
Vref2
High/Low
12 サンプルホールド回路
9 電圧比較回路



入力電圧Vi
AND回路15
7駆動回路
13
パルス
発振回路
7aP型
Vctr
電圧制御
発振回路
ストローブ端子P
6A
N型トランジスタ7b
High / Low
Vref2
9
電圧比較回路
基準電圧
バッファ12a
Vri
整流
Vref1
基準電圧
誤差増幅回路5
12c
スイッチ
12
サンプルホールド回路
12b充電コンデン